

All steel parts shall be galvanized per AASHTO M 111. Steel bolts and related connecting hardware shall be galvanized per AASHTO M 232.

9-28.12 Reflective Sheetings

This section is revised to read:

Type I and Type II reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface. Type III and Type IV reflective sheeting shall consist of spherical or prismatic lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. Type V reflective sheeting shall consist of metallized microprismatic lens bonded to a flexible, smooth-surfaced, weather resistant polymeric film. Type VI reflective sheeting shall consist of unmetallized microprismatic lens formed on a flexible vinyl material. Type VII, VIII, IX and Type X Fluorescent Orange reflective sheeting shall consist of unmetallized microprismatic lens formed in a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. All sheeting shall be weather resistant and have a protected pre-coated adhesive backing. Type II reflective sheeting shall contain an identifying marking, such as a water mark, which is visible after sheeting application. The marking shall not adversely affect the performance or life of the sheeting.

The reflective sheeting shall have the following minimum coefficient of retroreflection values at 0.2 degrees and 0.5 degrees observation angle expressed as average candelas per foot-candle, per square foot of material. Measurements shall be conducted in accordance with ASTM E 810.

Type I Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	70	50	25	9.0	14	4.0	1.0	
0.2°	+30°	30	22	7.0	3.5	6.0	1.7	0.3	
0.5°	-4°	30	25	13	4.5	7.5	2.0	0.3	
0.5°	+30°	15	15	4.0	2.2	3.0	0.8	0.2	

Type II Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	140	100	60	30	30	10	5.0
0.2°	+30°	60	36	22	10	12	4.0	2.0
0.5°	-4°	50	33	20	9.0	10	3.0	2.0
0.5°	+30°	28	20	12	6.0	6.0	2.0	1.0

Type III Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-4°	250	170	100	45	45	20
0.2°	+30°	150	100	60	25	25	11
0.5°	-4°	95	62	30	15	15	7.5
0.5°	+30°	65	45	25	10	10	5.0

Type IV Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	210	35	35	20	7.0
0.2°	+30°	80	54	92	9	9	5.0	2.0
0.5°	-4°	135	100	100	17	17	10	4.0
0.5°	+30°	55	37	52	6.5	6.5	3.5	1.4

Type V Metallized Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	700	470	280	120	120	56
0.2°	+30°	400	270	160	72	72	32
0.5°	-0.4°	160	110	64	28	28	13
0.5°	+30°	75	51	30	13	13	6.0

Type VI Vinyl Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	250	170	70	30	35	20
0.2°	+30°	95	64	26	11	13	7.6
0.5°	-0.4°	200	136	56	24	28	18
0.5°	+30°	60	40	17	7.2	8.4	4.8

Type VII Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	750	560	280	75	150	34
0.2°	+30°	430	320	160	43	86	20
0.5°	-0.4°	240	180	90	24	48	11
0.5°	+30°	135	100	50	14	27	6.0

Type VIII Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-0.4°	700	525	265	70	105	42	21
0.2°	+30°	325	245	120	33	49	20	10
0.5°	-0.4°	250	190	94	25	38	15	7.5
0.5°	+30°	115	86	43	12	17	7	3.5

Type IX Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	380	285	145	38	76	17
0.2°	+30°	215	162	82	22	43	10
0.2°	-0.4°	240	180	90	24	48	11
0.5°	+30°	135	100	50	14	27	6.0
1.0	-0.4°	80	60	30	8.0	16	3.6
1.0	+30°	45	34	17	4.5	9.0	2.0

Type X Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	FLUORESCENT ORANGE
0.2°	-0.4°	200
0.2°	+30°	90
0.2°	-0.4°	70
0.5°	+30°	26

The wet performance measurements on unweathered sheeting shall be conducted in accordance with one of the following methods:

1. The standard rainfall test specified in Federal Specification LS 300C and the brightness of the reflective sheeting totally wet by rain shall not be less than 90 percent of the above values.
2. Samples shall be submerged in a tank of clean water (approximately 72 F) for a period of 5 minutes. Reflex-reflective performance of the sheeting shall be viewed in a darkened room by reflected light through the surface of the water or through a transparent plane surface of the tank parallel to the sample surface. Light source shall be such as a hand flashlight held close to the eye. The wet sheeting shall show no apparent loss of reflective performance as compared to dry material.

The sheeting shall conform to the applicable daytime color and luminance factor requirements of ASTM D 4956 when tested instrumentally in accordance with Section 8.4 of that specification; OR, the diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparison shall be made under north daylight or a scientific daylight having a color temperature from 6500 degrees to 7500 degrees Kelvin. Daytime color evaluation shall be illuminated at 45 degrees and viewed at 90 degrees. There shall be no significant color shift when viewed under nighttime (retroreflective) conditions.

The reflective sheeting shall have a pre-coated pressure sensitive adhesive (Class 1) or a heat-activated adhesive (Class 2) either of which will adhere to flat, clean surfaces without necessity of additional adhesive coats on the reflective sheeting or application surface. Chemical activators shall not be used to activate Class 2 adhesive. The pre-coated adhesive shall be protected by an easily removed liner which, when removed, shall not have a staining effect on the reflective sheeting and shall be mildew resistant. The protective liner attached to the adhesive shall be removable by peeling without soaking in water or other solvents and shall be easily removed after storage for 4 hours at 150 F under weight of 215 psi. The sheeting with liner removed, conditioned for 24 hours at -72 F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 1.2-inch diameter mandrel with the adhesive side contacting the mandrel. For ease of testing, talcum powder may be spread on the adhesive to prevent sticking to the mandrel. The sheeting surface shall be smooth and flat to facilitate self-cleaning in the rain, regular cleaning, and wet performance, and exhibit 85 degrees glossmeter rating of not less than 50 when tested in accordance with ASTM D 523. The sheeting surface shall be readily processed and compatible with transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application. The sheeting shall permit cutting and color processing at temperatures of 60 F to 100 F and 20 to 80 percent RH. The sheeting shall be heat resistant and permit force curing without staining of unapplied sheeting or

1 applied sheeting at temperatures recommended by the manufacturer not to exceed
2 150 F for unapplied sheeting or 200 F for applied sheeting. The sheeting surface shall
3 be solvent resistant to permit cleaning by wiping with a clean soft cloth dampened with
4 VM&P Naphtha or mineral spirits.

5
6 The adhesive shall form a durable bond to smooth, corrosion and weather resistant
7 surfaces and permit the reflective sheeting to adhere securely, 48 hours after
8 application at temperatures of -30 F to 200 F. The adhesive bond shall be sufficient to
9 render the applied sheeting vandal-resistant and prevent its shocking off when
10 subjected to an impact energy of 20 ft. lbs. applied with a hemispherical tipped object
11 1 inch in diameter at -0 F. The test specimen shall be applied to aluminum backing not
12 less than 0.080 inch thick and having a dimension of not less than 4 inches square.
13 During testing, the specimen shall be supported on a 3-inch diameter ring.

14
15 The adhesion test shall conform to ASTM D 4956 with the addition of the temperatures
16 noted above.

17
18 The resistance to accelerated weathering shall be as described in ASTM D 4956 except
19 the weathering apparatus and procedure shall be in accordance with ASTM G 154.

20
21 The reflective sheeting shall be sufficiently flexible to be cut to shape easily and permit
22 application over, and conform to, moderate shallow embossing characteristic of certain
23 sign borders and symbols. The tensile strength of the sheeting shall be 5 to 20 pounds
24 per square inch width when conditioned for 48 hours in accordance to ASTM D 685 and
25 tested in accordance with ASTM D 828. Following liner removal, the reflective sheeting
26 shall not shrink more than 1/32 inch in ten minutes nor more than 1/8 inch in 24 hours in
27 any dimension per 9 inch square at 72 F and 50 percent relative humidity.

28
29 The sheeting, when applied according to manufacturer's recommendations to cleaned
30 and etched 0.020-inch ∞ 2-inch x 8-inch aluminum, conditioned (24 hours) and tested at
31 72 F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking
32 when bent around a 3/4-inch diameter mandrel.

33 34 **9-28.14(1) Timber Sign Posts**

35 This section is revised to read:

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37 At the Contractor's options, timber sign posts and mileposts shall be treated Douglas fir,
38 or treated Hem-fir meeting the grades specified in Section 9-09.2. Douglas fir and Hem-
39 fir posts shall be given a treatment in accordance with Section 9-09.3(1). Preservative
40 retention shall be as shown in section 9-16.2(3) for sawn posts.

41 42 **9-28.14(2) Steel Structures and Posts**

43 This section is revised to read:

44
45 Truss chords, struts, and diagonals, end posts, and end post struts and diagonals for
46 sign bridge structures and cantilever sign structures shall conform to either ASTM A 36
47 or ASTM A 53 Grade B Type E or S. The nominal pipe diameter and the pipe wall
48 thickness shall be as specified in the Plans or Standard Plans. All other structural steel
49 for sign bridge structures and cantilever sign structures shall conform to ASTM A 36.
50 Truss member connection hardware shall conform to Section 9-06.5(3).
51

Pipe members for bridge mounted sign brackets shall conform to ASTM A 53 Grade B Type E or S, and shall be Schedule 40 unless otherwise specified. All other structural steel for bridge mounted sign brackets shall conform to ASTM A 36. U bolts, and associated nuts and washers, shall be stainless steel conforming to Section 9-28.11, and shall be fabricated hot.

Anchor rods for sign bridge and cantilever sign structure foundations shall conform to ASTM F 1554 Grade 105, including Supplemental Requirements S2, S3, and S5. Nuts and washers for sign bridge and cantilever sign structure foundations shall conform to AASHTO M 291 Grade DH and AASHTO M 293, respectively.

Steel sign structures and posts shall be galvanized after fabrication in accordance with AASHTO M 111, unless noted otherwise in the Plans. All bolts, nuts, and washers shall be galvanized after fabrication in accordance with AASHTO M 232. Unless otherwise specified in the Plans or Special Provisions, metal surfaces shall not be painted.

Minor fabricating and modifications necessary for galvanizing will be allowed if not detrimental to the end product as determined by the Engineer. If such modifications are contemplated, the Contractor shall submit to the Engineer, for approval, six copies of the proposed modifications, prior to fabrication.

9-28.15 Sign Lighting Luminaires

This section is revised to read:

Sign lighting luminaires shall be either Mercury Vapor or Induction.

This section is supplemented with the following:

9-28.15(1) Sign Lighting Luminaires – Mercury Vapor

Sign lighting luminaires shall have a cast aluminum housing and door assembly with a polyester paint finish.

The housing shall encase a reflector, lamp socket, and ballast. It shall have a front entry (the side facing the sign) suitable for 1/2 inch conduit and mounting holes for attaching to a fixture mounting plate. Any additional entries shall have suitable plugs. The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the plans. If the sign structure includes a maintenance walkway, the luminaire fixture mounting plate shall be bolted to the walkway grating. Condensation drain holes shall be provided as recommended by the manufacturer.

The door shall be hinged to the housing on the side of the fixture away from the sign panel and shall be provided with two captive devices. The door shall be provided with the means to allow the door to be locked in the open position 70° to 90° from the plane of the door opening. The juncture of the door and housing shall be gasketed to provide a rain tight and dust tight joint.

Refractors shall be manufactured from heat resistant borosilicate glass. The refractor shall be shielded so that no light source is visible from the sign viewing approach. The shield shall be an integral part of the door assembly. When called for in the plans, fixtures shall be provided with a wire guard to prevent damage to the refractor.

1 The light source shall be a 175 watt deluxe phosphor coated mercury vapor lamp. The
2 lamp socket shall be porcelain enclosed mogul type containing integral lamp grips to
3 ensure electrical contact under conditions of normal vibration. The center contact shall
4 be spring loaded. The shell and center contact shall be rated for 1500 watts, 600 volts.

5
6 An isolation switch shall be installed in a NEMA 3R stainless steel terminal cabinet per
7 standard specification 9-29.25. The terminal cabinet shall be installed in accordance to
8 the Standard Plans. The switch shall be either single pole, single throw, or double pole
9 single throw as necessary to open all conductors to the luminaires other than neutral
10 and ground conductors. The switch shall contain 600 volt alternating current (VAC)
11 terminal strips on the load side with solderless lugs as required for each load carrying
12 conductor plus four spare lugs per strip.

13
14 Each fixture shall be provided with a fusible terminal block. Fuses shall be 10 amp, 250
15 VAC for 120 VAC circuits and 5 amp 600 VAC for 240 VAC and 480 VAC circuits. The
16 primary voltage shall be as indicated in the plans. Photometric performance shall be as
17 follows:

18
19 The ratio of the maximum to minimum illuminance level on a panel 10 feet high by
20 16 feet wide shall not numerically exceed 5:1 approaching 1:1. In addition, the
21 illuminance gradient shall not numerically exceed 2:1, illuminance gradient being
22 defined as the ratio of the minimum illuminance of a square panel 1 foot on a side
23 to that of any adjacent panel of the same size. This performance shall be obtained
24 when the fixture is mounted 1 foot below the bottom edge of the sign and 5 feet out
25 from the sign face.

26
27 The average to minimum uniformity ratio for a panel as dimensioned above shall
28 not numerically exceed 3:1. Average initial illuminance shall exceed 10 foot candles
29 for a mercury vapor lamp of 175 watts as specified.

30 31 **9-28.15(2) Sign Lighting Fixtures-Induction**

32 Induction sign lighting fixture shall conform to the provisions for mercury sign lighting
33 fixtures except as modified below:

34
35 Each fixture shall consist of a housing a reflector, refractor or lens, lamp socket,
36 lamp, power coupler, a high frequency (HF) generator and a fuse block, door, front
37 entry (the side facing the sign) suitable for 1/2 inch conduit and mounting holes for
38 attaching to a fixture mounting plate. Any additional entries shall have suitable
39 plugs. The sign lighting luminaire shall be supported by a lighting bracket assembly
40 as detailed in the plans. The door shall be hinged to the housing on the side of the
41 fixture away from the sign panel and shall be provided with two captive devices.
42 The door shall be provided with the means to allow the door to be locked in the
43 open position 70° to 90° from the plane of the door opening. The juncture of the
44 door and housing shall be gasketed to provide a rain tight and dust tight joint.

45
46 Refractors or lens shall be manufactured from heat resistant glass. The refractor or
47 lens shall be shielded so that no light source is visible from the sign viewing
48 approach. The shield shall be an integral part of the door assembly. When called
49 for in the plans, fixtures shall be provided with a wire guard to prevent damage to
50 the refractor.
51

1 The ratio of the maximum to minimum illuminance level on a panel 10 feet high by
2 16 feet wide shall not numerically exceed 9:1 approaching 1:1. In addition, the
3 illuminance gradient shall not numerically exceed 2:1, illuminance gradient being
4 defined as the ratio of the minimum illuminance of a square panel 1 foot on a side
5 to that of any adjacent panel of the same size. This performance shall be obtained
6 when the fixture is mounted 1 foot below the bottom edge of the sign and 5 feet out
7 from the sign face.

8
9 The average to minimum uniformity ratio for a panel as dimensioned above shall
10 not numerically exceed 4:1. Average initial illuminance shall exceed 10 foot candles
11 for an induction lamp of 85 watts as specified.

12
13 The system lifetime shall be rated at 60 000 hours with a failure rate of less than 10
14 percent. The system shall be rated at a nominal wattage of 87 W, 120/240 or
15 480V(ac). The power factor of the system shall be greater than 90 percent and the
16 total harmonic distortion (THD) shall be less than 10 percent. The system shall be
17 UL approved for wet locations and be FCC Class a listed.

18
19 The mounting assembly shall be either cast aluminum, hot-dip galvanized steel
20 plate or steel plate that has been galvanized and finished with a polymeric coating
21 system or the same finish that is used for the housing. The overall weight of the
22 fixture shall not exceed 44 pounds. The manufacturer's brand name, trademark,
23 model number, serial number and date of manufacture shall be located on the
24 packaged assembly and on the outside and inside of the housing.

25 26 **Housing**

27 The housing shall have a door designed to hold a refractor or lens. The
28 housing door shall be designed to be opened without the use of tools. The
29 housing and door shall have polyester paint finish of a gray color resembling
30 unfinished fabricated aluminum.

31 32 **Reflector**

33 The reflector may be designed to be removed as a unit that includes the lamp
34 and power coupler.

35 36 **Lamp**

37 Each fixture shall be furnished with an 85-W induction lamp. The interior lamp
38 walls shall be fluorescent phosphor coated. Lamp light output shall be not less
39 than 70 percent at 60 000 hours. Lamps shall have a color-rendering index
40 (CRI) of not less than 80. Lamps shall be rated at a color temperature of 4 000
41 K. Lamps shall be removable without the use of tools.

42 43 **Power Coupler**

44 The power coupler shall consist of a construction base with antenna, heat sink
45 and electrical connection cable.

46
47 The power coupler shall be designed so that it can be removed with no more
48 than common hand tools.

49 50 **High Frequency Generator**

51 High frequency (HF) generators shall provide reliable lamp starting and
52 operation at ambient temperatures down to -15° F for the rated life of the lamp.

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The generator output frequency shall be 2.65 MHz +/- 10 percent. The generator radio frequency interference shall meet the requirements of Part 18 of the FCC.

High frequency generators shall be designed for continuous operation at ambient air temperatures from -5°F to 80°F without reduction in generator life. High frequency generators shall have a design life of not less than 100,000 hours at 130° F.

A Certificate of Compliance, conforming to the provisions in Section 6-1.07, "Certificates of Compliance," and a copy of the high frequency generator test methods and results shall be submitted by the manufacturer with each lot of sign lighting fixtures. The certificate shall state that the high frequency generators meet, in every respect, the above requirements and the generator specifications of the lamp manufacturer.

High frequency generators shall also conform to the following:

- A. High frequency generators shall be capable of being easily replaced. All conductor terminals shall be identified as to the component terminal to which they connect.
- B. High frequency generators shall be mounted so as to use the portion of the sign lighting fixture upon which they are mounted as a heat sink.